

Problems In Seafood Availability:

A teaser often posed by futurologist to a planner is "Can the mother earth feed its ever-growing human population by the year 2050 A.D". From the turn of the wheel of time machine, one may profess that in the next five decades, the yielding capacity of "terra firma" i.e. the land is not going to increase, any further. As such, on a global scale, in the near future, only marginal land may be available for growing food crops or for raising livestock.

Such a gloomy sceanario, makes one to turn to the vast expanse of seas and the oceans. How much does the oceans, accounting for almost 72% of the earth's surface, contribute to the dietary requirements of human population. From times immemorial, it has been emphasized that the world oceans are inexhaustible storehouse of food resources. Of course, the harvest of seafoods, through marine fisheries has increased in India as elsewhere. At the time of our independence, the marine fish catch which was 6 lakh tons per year has gone upto 20 lakh tons per year by 1991-92, i.e. in 45 years. The annual harvest of seafood in India has trebled but with a slow and irregular growth rate. Simultaneously, the demand for seafoods has also increased considerably, due to ever-increasing population size. In most of the world oceans as in seas around India, the growth of marine fisheries has become static and no substantial increase is in sight.

A realistic assessment of the potential seafood resources, reveals that any further increase in harvest of seafood may not be substantial; and also may not be economical. This is mainly due to the overfishing of traditional nearshore fishing grounds, and, secondly, because of the high operational cost and low yield situation in the distant water and deep sea fishing.

What is Seafarming or Aquaculture:

What are the other ways and means for generating and harvesting the seafoods on a long term and sustainable basis? One of the most promising avenue for producing substantial quantity of seafood is through sea farming or culture fisheries. Often called as mariculture; Coastal Aquaculture or Aquaculture, the farming of the sea is an ancient bioindustry with traditions well rooted in the past.

It is supposed to have originated in 100 B.C., when a delicacy like oysters, could be raised in impoundments, for gastronomic pleasures of the royal families. In India, as elsewhere in the Asian countries like China and Japan, traditional sea farming practices, like "khazan" and "manas" in Goa; "Pokkali" in Kerala and "bhasa bhada" in West Bengal, do exist for centuries, together.

Farming of sea, essentially involves the taming and growing of economically important animals and plants, under partially controlled environmental conditions. Seafarming is an integrated and multifaceted bioindustry encompassing biology, chemistry, food technology, economics, business management and sociology.

Traditional Practices of Seafarming:

The methods and practices of seafarming are traditional and involve composite culture of wild stock. Despite the complete ignorance of modern methods of livestock management and animal husbandry principles, the traditional fish farmers seem to know many relevant facts, especially by practical experiences gained through many generations.

In Goa, as elsewhere along the west and east coast of India, the brackish water ponds, locally known as "agar" or low lying "khazan" lands, are used to serve different purposes. Some of the ponds are exclusively used for fish farming; others for salt-cum-fish culture (locally known as "mitache agar") whereas the part of khazan lands are used for permanent or "manas" fish farms and/or paddy-cum-prawn/fish culture. Latter is most common in Kerala and West Bengal.

1- Permanant Fish Farm:

These ponds of varying dimension of 100 to 5000 sq.m. are generally situated close to the estuary or river adjoining the sea. Such ponds are characterized by dense mangrove vegetation in the surrounding area. The ponds are bounded by mud or clay embankment strengthened with lateritic stones and boulders. The flow of water, in and out of the farm is regulated through a sluice gate (locally known as "manasi"), fitted with wooden planks.

Stocking of the farm generally coincides with the onset of rains in June. Sluice gate is kept open, especially during the high or flood waters of the spring and neap high tide, thus allowing the free exchange of water. Tidal flow allows the entry of fish and prawn larvae i.e. young ones into the pond. These young ones continue to grow in the protected environs of the pond and in 3-4 months i.e. by September-October, the grown-up prawns and fishes make an effort to move out. At this time, the water level in the pond is regulated by allowing the exchange only during the low tide. To prevent the escape of fish and prawn, the sluice gates are fitted with fine mesh conical nets. Several branches of thorny shrubs are placed on the border of the fish farm to prevent netting or poaching. Harvesting of fish and prawns, which, by then attain marketable size, is done by nets fixed at the sluice gate, but at times, drag nets and/or cast nets are also used.

Traditional fish farming may be either :

- a - Continuous fish and prawn culture all the year round
- b - Secondary crop of fish and prawns (November-April) after harvesting of paddy (June-September).
- c - Salt-cum-fish production : Salt production (February-May); fish farming (June-October).

Commonly Cultivated Species:

Prawns mostly "white" (Penaeus indicus and Metapenaeus monoceros) ;and "tiger" or "waghi" (Penaeus monodon). Important species of fish are : "mulletts" or "shevtali" (Mugil cephalus and Mugil parsia); "milkfish" or "gholshi" (Chanos chanos); "pearl spot" or "kalundra" (Etroplus suratensis); "bhekti" or "chanyak" (Lates calcarifer). Species of lesser importance are "tamboshi" (Lutianus sp.) ; "Kharchani" (Gerres sp.) and "banoshi" (Thenus sp.).

Economics of Traditional Seafarming:

As deduced from the reported case history studies of traditional fish farming in Goa, and the details are as follows:

CASE STUDY I

Cost & Benefit Analysis of Traditional Seafarming - Goa

Area of farm	:	3 hectares
Number of fishing days	:	80
Quantity of fish & prawns caught/day	:	40 kg
Total yield (80x40)	:	3200 kg
Cost of catch (at Rs.25/kg)	:	Rs. 80000

Expenditure:

Rs.

b) Other expenses - including maintenance, unforeseen, net mending etc.	:	5,000
c) Annual lease charge	:	6,000
Sub-total	:	<u>42,200</u>

Returns

i. Gross profit (cost of catch-expenditure)	:	37,800
ii. Profit per hectare	:	12,600

Rate of Returns

i. Cost of Production	:	42,200
ii. Value of Produce	:	80,000
iii. Gross Profit	:	37,800
iv. Profit Margin	:	89.57%

CASE STUDY II

Cost Benefit Analysis Of Traditional Salt-cum-Fish Farming In Goa

Area of salt works-cum-fish farm	:	10.5 hectares
Number of fishing days	:	4-6
Quantity of fish & prawns caught per day	:	700 kg
Total catch	:	3500 kg
Cost of catch (at Rs. 25/kg)	:	Rs. 87,500
Income from salt (1200 bags of 50 kg each at Rs. 40/bag)	:	Rs. 48,000
Total income	:	Rs. 1,35,500

<u>Expenditure</u>	Rs.
a) Labour charges	: 65,000
b) Other expenses - including maintenance, pump hiring, unforeseen etc.	: 12,500
c) Annual lease charge (25% of total salt income)	: 12,000
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Sub-total :	89,500
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Returns

i. Gross Profit (Total income - Total expendi- ture	: 46,000
ii. Profit Per Hectare	: 4,380

Rate of Returns

i. Cost of Production	: 89,500
ii. Value of Produce	: 1,35,500
iii. Gross Profit	: 46,000
iv. Profit Margin	: 51.40%

The cost benefit analysis for a traditional seafarm yielded 1066 kg/ha/yr, with cost of production of Rs. 14065/ha and a gross profit of Rs. 12600/ha, thus giving a high rate of return of 89.57% on the expenditure. Similarly, in the salt-cum-fish farming, per hectare yield of fish and prawn was 333 kg and of salt 5715 kg; with cost of production of Rs. 8523/ha and a gross profit of Rs. 4380/ha, giving a rate of return of 51.40% on the expenditure. Such cost-effective practices of traditional seafarming are in vogue in the coastal areas of India and many of the south-east and far-east Asian countries.

However, the traditional practices of seafarming lack modern scientific and management basis or principles. No special attention is being paid for improving the stock of cultivable species and, therefore, the success or failure depends on the natural availability and abundance of larvae or "seeds". No proper measures are being practised and/or implemented for controlling the predation and diseases. Similarly, no

proper attention is paid to the requirement of food in the pond. Another serious problem for small scale fish farmers is the poaching or theft of the farmed fish.

the farmed fish and prawn.

In spite of the above mentioned constraints, the prospects of seafarming by application of scientific methods are really bright.

Seafarming - Global Perspective:

In the last 30 years or so, as a result of intensive Research and Development efforts, great strides have been made in the area of seafarming. New high yielding, disease resistant, fast growing strains have been evolved and it has resulted in bringing into use, the multicropping concept in seafarming.

Japan and China have a long history in seafarming or aquaculture and the growth in the industry has been simulated by decreased catches from the traditional fishing grounds. Major changes over the past few years are :

- introduction of new cultured species
- use of formulated feeds
- monitoring of environmental parameters
- appropriate seafarming techniques and management

In some of the advanced seafarming countries, like, Japan, China and Taiwan, the seafarming or aquaculture industry still relies on small scale operations.

Taiwan has developed its expertise in aquaculture and used it to develop a major export-oriented industry. Exports of seafood products from Taiwan in the year 1990 was worth US dollars 1.26 billion. Taiwan has now 70 species under production, with another 35 species as under study candidates for commercial production.

Another alternative has been the expansion of seafarming in countries like Thailand, Phillipines and Ecuador, with available coastal land, warm climate that allow year round production and lower labour costs. The success of prawn/shrimp farming has led to increased conversion of coastal lands, including paddy fields into aquaculture or seafarming farms. In some of the countries, especially Ecuador and Indonesia, where large tracts of coastal mangroves were modified into seafarming ponds, severe environmental problems in the form of lowering of productivity; increase in soil acidity; erosion of bunds etc. has been observed. Similarly, in large scale prawn farming in Taiwan and Malaysia, the tiger prawn production was severely affected by massive viral infections (mainly Monodon baculovirus and "yellow-head disease") that reduced production by 70% and exports by 80%.

Production has also been affected by :

- increased salination of ground water
- deterioration of water quality due to left over high protein feed
- indiscriminate use of antibiotics

However, the remedial measures have been evolved through continuous R&D efforts. The World Seafarming Production, as seen from enclosed tabulation, was 12 million tonnes in 1990-91 and was worth 140 billion US dollars in export market. The annual production has shown a steep increase from 3.5 million tonnes in 1980 to 12 million tonnes in ten years and is projected to increase to 50 million tonnes per year by 2050 AD or may be even earlier.

As seen from enclosed data, Asia & Oceania (Australia & New Zealand), accounts for 87.5% of total seafood production, followed by Europe & Russia, as poor second with 9.4%. Relatively, America and Africa, have still to make headway in this highly potential economic activity. While finfishes and molluscs, (including bivalves, such as oysters, mussels, scallops, clams and gastropods, mainly, abalone), together account for 80.5% of the total seafarming produce, prawns and lobsters - account for 60% value realization. While the crustacean production has increased from 71,246 tonnes in 1980 to 6,38,360 tonnes in 1990-91, there is a decline in the production of seaweeds from 2,206,484 tonnes in 1980 to recent times production of 170,7684 tonnes, in 1990-91.

WORLD SEAFARMING PRODUCTION FOR 1990-91
(metric tonnes)

Region	Species / Group				Total	Percentage contribution
	Finfish	Mollusc	Crustaceans	Seaweeds		
Asia & Oceania	4,516,203	3,770,000	5,30,260	1,706,434	10,522,897	87.54
Europe & Russia	630,196	505,516	100	50	1,135,862	09.44
South America	65,420	90,993	1,00,000	-	2,56,413	02.13
North America	35,500	56,400	8,000	1200	1,01,100	0.84
Africa	6,000	550	-	--	6.550	0.05
Total	5,253,319 (43.69%)	4,423,45 (36.79%)	6,38,360 (05.31%)	1,707,684 (14.20%)	12,022,82	100.00

Source : Genetic Engineering News (USA) 10, April, 1993

Advantages of Seafarming:

Some of the plus points of seafarming or aquaculture over the conventional marine fisheries are :

- i. dispensing with expensive equipments like fishing vessels and fishing gears. Seafarming being highly labour intensive activity, offer many more self-employment and/or job opportunities especially for untrained and unskilled manpower.
- ii. relatively low capital and operational or recurring expenditure.
- iii. uniformly high and consistent yields which can be calculated and augmented, well in advance.
- iv. considerably low possibilities of loss of manhours due to inclement weather or breakdown of crafts and tackle.
- v. additional possibilities of taking up breeding and hatchery activities, as a profitable supplementary income.
- vi. involves the prevention of pollution by using recycled industrial and domestic wastes for regenerating seafoods.

Constraints In Seafarming:

Being a most promising area in the priority field of food production, seafarming or aquaculture, has following limitations, due to :

- a) absence of definite policies for coastal spaceutilization : coastal zone providing most promising sites for seafarming is an area of clash of interest for fishing, navigation, human dwellings, agriculture/horticulture, industrial sites, tourism, recreation, marine sports, defense etc.
- b) non-availability of quality seeds/spats/fingerlings on sustained basis.
- c) expensive feeds resulting in high operational costs.
- d) everincreasing danger of pollution of marine environment.

Seafarming - National Scene:

While seafarming is deeply rooted in the traditions of the coastal population of India, the modern seafarming or aquaculture, is receiving recognition as an area of development towards primary marine bioindustry. Though we have more than 2 million hectares of area available in the coastal zone with good prospects of utilization under seafarming, less than only 80,000 hectares are presently being used, both for traditional and modern seafarming.

However, the global trend of diverging from capture marine fisheries to culture fisheries through aquaculture or seafarming is making its headway on the national scene. Due to concerted efforts of Research & Development by a number of marine and oceanographic research institutions; fishery and maritime universities and large industrial houses, a number of techno-economically feasible methods of seafarming have been in advanced stages of technology transfer to potential users.

A resume of seafarming techniques, perfected in recent years in India, is given in the tabulation (enclosed) and details are as follows:

i. Seaweeds :

These are marine algal species, having use as food, feed and in pharmaceutical industry. Seaweeds, which normally occur in shallow waters and grow attached to rock or in sand, are grown by rope nets fixed in the coastal bays and lagoons. Commonly cultivated species are Gelidiella, Gracilaria, Hypnea and Sargassum. Though production varies from species to species, the average production is reported to be 3 kg/m² in 8-10 weeks. Potential sites are Gulf of Kutch (Gujerath), Palk Bay and Gulf of Mannar (Tamil Nadu) and Lakshadweep group of islands.

ii. Green Mussels :

A bottom living edible bivalve, is grown by off-bottom culture on hanging ropes from a floating raft anchored in estuaries or bays or offshore waters. Marketable size of 60 mm is attained in 4 to 5 months with a production of 480 tonnes/hectare and profitability of 181%. Suitable for commercial production, both in inshore and offshore regions and on round the year basis.

iii. Brown Mussels:

A bottom dweller, more commonly found along Kerala and South

Malnadu coast, can be grown by raft culture, and reported to give a yield of 150 tonnes/hectare in about 8 months time.

iv. Edible Oyster:

A delicacy, commonly found attached to rock and hard objects in creeks, estuaries and open sea coast, is farmed by offbottom culture in sandwich nets; nylon bags or on poles. Gives a high yield of 100 tonnes per hectare in 9 to 10 months with a rate of returns of 95%. An appropriate technique for round the year production in nearshore waters.

v. Blood Clams :

Most commonly found in sandy bottom along some part of the Andhra Pradesh coast. Experimental culture by relaying on seafloor, produced 2.2 kg/m² in less than 8 months. Good export potential in South East Asian markets.

vi. Hard Clams :

Very commonly occurring in sandy and muddy bottoms all along the Indian Coast. Appropriate technique of ground relaying gives a yield of 1.5 kg/m² in 9 to 10 months. Good local market sale, available.

vii. Pearl Oyster:

An ornamental variety of marine living resource, naturally occurring on some parts of the coast of Gujerath, Tamilnadu and Andaman - Nicobar group of islands. Natural populations greatly depleted due to adverse human activities. Indigenous technique developed and perfected to introduce synthetic nucleus and grow the pearl oysters on floating rafts by off bottom culture. 60% success in production of perfect spherical pearls (1-3 pearls per shell) in 3 to 4 months, achieved.

viii. Brine Shrimp :

A tiny arthropod naturally occurring all along the Indian Coast, inhabiting the salt pans, has in recent times, came into prominence as an efficient feed organism in prawn and fish farming. Very good export market exists for the commodity. Feasible technique of growing brine shrimp in modified salt pans, gives a high yield of 35 kg per hectare in 4 to 5 months and fetches a rate of return of 65% on the investment.

ix. Prawn/shrimp :

Most sought after seafood, commanding an ever-increasing demand in

international market. India exports about 85,000 tonnes of prawn per year and earns also Rs. 1000 crores in foreign exchange. However, only less than 20,000 tonnes of it comes from seafarming. In recent years, Andhra Pradesh, West Bengal and Tamilnadu have witnessed rapid development of prawn farms and the trend and tempo is spreading to other maritime states of India.

x. Milk Fish:

A fast growing species, traditionally being farmed in composite or mixed culture along with finfishes and prawns. Experimental monoculture gives a high yield of 1100 kg/ha within 8 to 9 months with assured profitability of 60%.

xi. Mulletts :

A common fish occurring in estuaries and nearshore waters of India, is traditionally cultivated by wild stocking in composite culture. Monoculture gives a good yield of 825 kg/ha in 7 to 8 months with a profitability of 70%.

xii. Pearl Spot :

A resident species of nearshore and brackishwater environment, all along the Indian Coast, is considered to be a delicious seafood. When grown in fish farm, under monoculture, gives a yield of 330 kg/ha in less than 8 months.

xiii. Eel:

A luxury food, in great demand, especially in Japan and South East Asian countries, has a peculiar life history of growing in freshwater and migrating for breeding in the sea. Occurs, naturally in most of the Indian rivers. The young ones "elevationers", while entering rivers from the sea, are trapped and grown in raceways. With, fish and clam meat as feed, the eel, under farming conditions, grow very fast and return a yield of 2.15 kg/m³ in 5 months. A commodity, having great export market.

xiv. Mixed Farming or Polyculture:

This involves the upgrading of traditional seafarming practices, wherein, all herbivorous species of fishes and prawns are grown in a farm. However, with proper stocking of selected seeds or young ones; supplementary feeding and control of diseases and predation, the yield can be 1.8 to 2 tonnes in 9 to 10 months with a rate of return of 55% on the expenditure. The yield comprises of 65% of fishes and 35% of prawns, which, of course can be modified with varying stocking densities of prawn

and fish, respectively.

Besides the above mentioned techniques of seafarming, experimental methods for commercial production of lobsters, crabs, sea cucumbers, squids and large variety of finfishes, are being perfected for transfer to commercialization.

As elsewhere, the seafarming or aquaculture in India, despite certain constraints of land-use policy; quality seed availability; infections and diseases; deteriorating environmental quality and inadequacy of processing and marketing infrastructure; is an area of high potential growth, both in the sector of small and large industry. With advantages of large unutilized coastal space, consistently warm and productive waters, less

pollution level and relatively cheap manpower the seafarming has an important role to play in the national development of our country.

Seafarming Techniques In India : Details

Commodity	Technique of Cultivation	Production (wt. per unit area)	Time For Production	Profitability
Seaweeds.	Rope Nets	3 Kg/m ²	8-10 weeks	N.A.
Green Mussels	Off Bottom: Floating Raft; Long Lines	48 kg/m ²	18-20 weeks	181%
Brown Mussels	- do -	15 kg/m ²	30-32 weeks	N.A.
Edible Oysters	Off Bottom : Racks; Sandwich Nets	10 kg/m ²	38-40 weeks	95%
Blood Clams	Ground Relaying	2.2 Kg/m ²	28-32 weeks	N.A.
Hard Clams	- do -	1.5 kg/m ²	36-40 weeks	N.A.
Pearl Oyster	Off Bottom : Floating Raft	60% i.e. 1-3pearl/shell	22-16 weeks	60%
Brine Shrimp	Salt Pans	35 kg/ha	18-20 weeks	65%
Prawn/Shrimp	Fish Farm	1400 kg/ha (6250 kg/ha)	20-22 weeks	40%
Milk Fish	- do -	1100 kg/ha	32-36 weeks	60%
Mulletts	- do -	825 kg/ha	30-32 weeks	70%
Pearl Spot	- do -	330 kg/ha	28-30 weeks	N.A.
Eel	Raceways	2.15 kg/m ³	20 weeks	N.A.
Mixed/Poly-culture (Fish & Prawn)	Fish Farm	1800-2000 kg/ha 65% fish; 35% prawns)	36-40 weeks	55%